CLAIMS

1. An apparatus for separating a volume of composite liquid into a first component, an intermediate component including a second component, and a third component, the volume of composite fluid being contained in a flexible separation bag connected to at least a first component bag and an intermediate component bag, the apparatus comprising:

a centrifuge having:

a rotor comprising:

a turntable for supporting the separation bag; and

a central compartment for containing the at least first and intermediate component bags;

a squeezing member for squeezing the separation bag and causing the transfer of at least one portion of the first component from the separation bag into the first component bag and the transfer of the intermediate component from the separation bag into the intermediate component bag;

a memory for storing at least one centrifugation speed allowing for the sedimentation of the first, the second and the third components in the separation bag, and information related to at least one first transfer flow rate of the first component into the first component bag and at least one second transfer flow rate of the intermediate component into the intermediate component bag, whereby the at least one first transfer flow rate and the at least one second transfer flow rate are different; and

a control unit programmed:

for receiving from the memory the at least one centrifugation speed and the information related to the at least one first transfer flow rate and the at least one second transfer flow rate; and

for causing the rotor to rotate at the at least one centrifugation speed; and

for causing, after sedimentation of the first, the second and the third components in the separation bag, the squeezing member to squeeze the separation bag so as to transfer the at least one portion of the first component from the separation bag into the first component bag at the at least one first transfer flow rate, and to transfer the intermediate component from the separation bag into the intermediate component bag at the at least one second transfer flow rate.

2. An apparatus according to claim 1, wherein the at least one first transfer flow rate is a substantially constant flow rate.

3. An apparatus according to claim 1, wherein the at least one second transfer flow rate comprises an initial flow rate and a final flow rate, the final flow rate being lower than the initial flow rate.

4. An apparatus according to claim 3, further comprising:

a first sensor for detecting the third component on a pathway of the intermediate component to the intermediate component bag; and

a second sensor for detecting the third component on a pathway of the intermediate component to the intermediate component bag upstream of the first sensor,

wherein the control unit is further programmed for receiving information from the first sensor and the second sensor and for causing the transfer of the intermediate component at the initial flow rate until the second sensor detects the third component and at the final flow rate until the first sensor detects the third component.

5. An apparatus according to claim 1, wherein the control unit is further programmed:

for causing, upon sedimentation of the first, second and third components in the separation bag, the squeezing member to squeeze the separation bag so as to transfer a first portion of the first component from the separation bag into the first

component bag at the at least one first transfer flow rate, while a second portion of the first component remains in the separation bag; and

for causing, after the transfer of the first portion of the first component into the first component bag, a variation of the centrifugation speed so as to mix the second component with the second portion of the first component and form the intermediate component.

6. An apparatus according to claim 5, wherein the control unit is further programmed for causing the rotor to rotate at a first centrifugation speed during the transfer of the first portion of the first component from the separation bag into the first component bag.

7. An apparatus according to claim 6, wherein the control unit is further programmed for causing a rapid decrease of the centrifugation speed from the first centrifugation speed to a second centrifugation speed so as to mix the second component with the second portion of the first component and form the intermediate component.

8. An apparatus according to claim 7, further comprising:

a first valve member mounted on the rotor for interacting with a first tube connecting the separation bag to the first component bag and selectively allowing or blocking a flow of first component therethrough;

a second valve member mounted on the rotor for interacting with a second tube connecting the separation bag to the intermediate component bag and selectively allowing or blocking a flow of intermediate component therethrough; and

wherein the control unit is further programmed for causing the first valve member to close and the second valve member to open during the mixing of the second component with the second portion of the first component and the formation the intermediate component.

9. An apparatus according to claim 1, wherein the control unit is further programmed:

for causing, upon sedimentation of the first, second and third components in the separation bag, the squeezing member to squeeze the separation bag so as to transfer a first portion of the first component from the separation bag into the first component bag at the at least one first transfer flow rate while a second portion of the first component remains in the separation bag;

for causing, after the transfer of the first portion of the first component into the first component bag, a rapid decrease in the centrifugation speed from a first centrifugation speed to a second centrifugation speed so as to cause a mixing of the second component with the second portion of the first component and the third component; and

for causing, after the mixing of the second component with the second portion of the first component and the third component, an increase in the centrifugation speed from the second centrifugation speed to a third centrifugation speed so as to separate the third component from an intermediate component comprising the second component and the second portion of the first component.

10. An apparatus according to claim 9, further comprising:

a first valve member mounted on the rotor for interacting with a first tube connecting the separation bag to the first component bag and selectively allowing or blocking a flow of first component therethrough; and

a second valve member mounted on the rotor for interacting with a second tube connecting the separation bag to the intermediate component bag and selectively allowing or blocking a flow of intermediate component therethrough,

wherein the control unit is further programmed for causing the first and the second valve members to close before causing the rapid decrease of the centrifugation speed from a first centrifugation speed to a second centrifugation speed.

11. An apparatus according to claim 10, further comprising a sensor for detecting the third component on a pathway of the intermediate component to the intermediate component bag, wherein the control unit is further programmed for:

receiving information from the sensor; and

causing the second valve to open and the squeezing member to transfer the intermediate component from the separation bag into the intermediate component bag when the sensor does not detect the third component any more after the centrifugation speed has been increased from the second rotation speed to the third rotation speed.

12. An apparatus according to claim 1, further comprising:

a first valve member mounted on the rotor for interacting with a first tube connecting the separation bag to the first component bag and selectively allowing or blocking a flow of first component therethrough;

a second valve member mounted on the rotor for interacting with a second tube connecting the separation bag to the intermediate component bag and selectively allowing or blocking a flow of intermediate component therethrough; and

a sensor for detecting the third component on a pathway of the first component to the first component bag,

wherein the control unit is further programmed for receiving information from the said sensor and for controlling the first and the second valve members.

13. An apparatus according to claim 12, wherein the control unit is further programmed for causing the transfer of the at least one portion of the first component from the separation bag into the first component bag by causing:

the first valve member to open;

the second valve member to close; and

the squeezing member to squeeze the separation bag until the sensor on the pathway of the first component to the first component bag detects the third component on a pathway of the first component to the first component bag.

14. An apparatus according to claim 13, further comprising a first sensor for detecting the third component on a pathway of the intermediate component to the intermediate

component bag, wherein the control unit is further programmed for receiving information from the first sensor.

15. An apparatus according to claim 14, wherein the control unit is further programmed for causing the transfer of the intermediate component from the separation bag into the intermediate component bag by causing:

the second valve member to open;

the first valve member to close; and

the squeezing member to squeeze the separation bag until the first sensor detects the third component on a pathway of the intermediate component to the intermediate component bag.

16. Apparatus according to claim 1, wherein the control unit is further programmed for causing a transfer of air from the separation bag into one of the component bags before the transfer of the first component from the separation bag into the first component bag.

17. An apparatus according to claim 1, wherein the composite liquid comprises whole blood, the first component comprises plasma, the second component comprises platelets, the third component comprise red blood cells, and the intermediate component comprises a suspension of platelets in plasma.

18. An apparatus according to claim 1, wherein

the squeezing member is further for causing the transfer of the third component into a third component bag connected to the separation bag;

the memory is further for storing information related to at least one third transfer flow rate of the third component into the third component bag, whereby the at least one third transfer flow rate is different from the at least one second transfer flow rate; and

the control unit is further programmed:

for receiving from the memory the information related to the at least one third transfer flow rate; and

for causing the squeezing member to squeeze the separation bag so as to transfer the third component from the separation bag into the third component bag at the at least one third transfer flow rate.

19. An apparatus according to claim 18, wherein the at least one third transfer flow rate comprises an initial flow rate and a final flow rate, the final flow rate being lower than the initial flow rate.

20. An apparatus according to claim 18, wherein, during the transfer of the third component from the separation bag into the third component bag, the control unit is programmed for causing the rotor to rotate at a centrifugation speed that is less than the rotation speed at which the rotor rotates during the transfer of the intermediate component into the intermediate component bag.

21. An apparatus according to claim 18, further comprising

a first valve member mounted on the rotor for interacting with a first tube connecting the separation bag to the first component bag and selectively allowing or blocking a flow of first component therethrough;

a second valve member mounted on the rotor for interacting with a second tube connecting the separation bag to the intermediate component bag and selectively allowing or blocking a flow of intermediate component therethrough; and

a third valve member mounted on the rotor for interacting with a third tube connecting the separation bag to the third component bag and selectively allowing or blocking a flow of fluid component therethrough,

wherein the control unit is further programmed for controlling the first, the second and the third valve members.

22. An apparatus according to claim 21, wherein the control unit is further programmed for causing the transfer of the third component from the separation bag into the third component bag by causing:

the third valve member to open;

the first and the second valve members to close; and

the squeezing member to squeeze the separation bag until it is substantially empty.

23. An apparatus according to claim 22, further comprising an empty sate sensor detecting sensor for detecting when the separation bag is substantially empty, wherein the control unit is further programmed for receiving information from the empty sate sensor and for causing the rotor to stop rotating after detection by the empty sate sensor that the separation bag is substantially empty.

24. An apparatus according to claim 23, further comprising a lid that can be secured on the turntable for enclosing the flexible separation bag, wherein the squeezing member comprises:

a flexible diaphragm secured to the turntable,

a pumping station for pumping a hydraulic fluid into and out of an expandable chamber delimited between the turntable and the flexible diaphragm, whereby the flexible separation bag is being squeezed against the lid when the hydraulic fluid is pumped into the expandable chamber; and

a pressure sensor for sensing the pressure of the hydraulic fluid, wherein the empty sate sensor for detecting when the separation bag is substantially empty is the pressure sensor.

25. An apparatus according to claim 24, wherein, during the transfer of the third component from the separation bag into the third component bag, the control unit is further programmed for causing the transfer of the third component at a first flow rate until the hydraulic pressure measured by the pressure sensor reaches a determined

pressure threshold, and at a second flow rate after the hydraulic pressure measured by the pressure sensor has reached the determined pressure threshold, the second flow rate being lower than the first flow rate.

26. An apparatus according to claim 25, further comprising a sensor for detecting a liquid on a pathway from the separation bag to the third component bag, wherein the control unit is further programmed receiving information from the sensor and for causing a transfer of air from the separation bag into the third component bags by causing:

the first and second valve members to close;

the third valve member to open; and

the squeezing member to squeeze the separation bag until the sensor detects the first component.

27. An apparatus for separating a volume of composite liquid into at least a first component and a second component, the volume of composite fluid being contained in a flexible separation bag connected to at least a first component bag and a second component bag, the apparatus comprising:

a centrifuge having:

a rotor comprising:

a turntable for supporting the separation bag; and

a central compartment for containing the at least first and intermediate component bags;

a squeezing member for squeezing the separation bag and causing the transfer of the first component from the separation bag into the first component bag and the transfer of the second component from the separation bag into the second component bag;

a memory for storing at least one centrifugation speed allowing for the sedimentation of the at least first and second components in the separation bag, and information related to at least one first transfer flow rate of the first component into

the first component bag and at least one second transfer flow rate of the second component into the second component bag, whereby the at least one first transfer flow rate and the at least one second transfer flow rate are different; and

a control unit programmed:

for receiving from the memory the at least one centrifugation speed and the information related to the at least one first transfer flow rate and the at least one second transfer flow rate; and

for causing the rotor to rotate at the at least one centrifugation speed; and

for causing, after sedimentation of the at least first and second components in the separation bag, the squeezing member to squeeze the separation bag so as to transfer the first component from the separation bag into the first component bag at the at least one first transfer flow rate, and to transfer the second component from the separation bag into the second component bag at the at least one second transfer flow rate.

28. An apparatus according to claim 27, wherein the composite liquid comprises whole blood, the first component comprises plasma and the second component comprises platelets.

29. An apparatus according to claim 27, wherein the composite liquid comprises whole blood, the first component comprises plasma and the second component comprises red blood cells.

30. A method for separating a volume of a composite liquid into a first component, an intermediate component including a second component, and a third component, whereby the volume of composite liquid is contained in a separation bag connected to at least a first component bag and an intermediate component bag, the method comprising the steps of:

spinning the separation bag at at least one centrifugation speed so as to centrifuge the volume of composite liquid and cause the sedimentation of the first, second and third components;

when the three components have sedimented, transferring at at least one first transfer flow rate at least one portion of the first component into the first component bag;

when the at least one portion of the first component has been transferred into the first component bag, transferring at at least one second transfer flow rate the intermediate component into the intermediate component bag, whereby the at least one first and at least one second transfer flow rates are different.

31. A method according to claim 30, wherein the at least one first the transfer flow rate is a substantially constant flow rate.

32. A method according to claim 30, wherein the at least one second transfer flow rate comprises an initial flow rate and a final flow rate, the final flow rate being lower than the initial flow rate.

33. A method according to claim 32, wherein the step of transferring the intermediate component into the intermediate component bag comprises the steps of:

transferring the intermediate component into the intermediate component bag at the initial flow rate until the third component is detected at a first location on a pathway of the intermediate component to the intermediate component bag; and

transferring the intermediate component into the intermediate component bag at the final flow rate until the third component is detected at a second location on a pathway of the intermediate component to the intermediate component bag, the first location being upstream of the second location.

34. A method according to claim 30, wherein the step of transferring at least one portion of the first component comprises transferring a first portion of the first

component from the separation bag into the first component bag, while a second portion of the first component remains in the separation bag.

35. A method according to claim 34, further comprising the step of mixing the second component with the second portion of the first component so as to form the intermediate component, after the transfer of the first portion of the first component into the first component bag.

36. A method according to claim 35, further comprising spinning the separation bag at a first centrifugation speed during the transfer of the first portion of the first component from the separation bag into the first component bag.

37. A method according to claim 36, wherein the step of mixing the second component with the second portion of the first component comprises rapidly decreasing the centrifugation speed from the first centrifugation speed to a second centrifugation speed.

38. A method according to claim 36, wherein the step of mixing of the second component with the second portion of the first component comprises:

rapidly decreasing the centrifugation speed from the first rotation speed to a second centrifugation speed that is substantially lower than the first centrifugation speed so as mix the second portion of the first component with the second component and the third component; and

increasing the centrifugation speed from the second rotation speed to a third centrifugation speed that is lower than the first centrifugation speed so as to separate the first component from a mix of the second component with the second portion of the first component forming the intermediate component.

39. A method according to claim 30, further comprising the step of transferring air from the separation bag into one of the component bags before transferring the first component from the separation bag into the first component bag.

40. A method according to claim 30, wherein the step of squeezing the separation bag comprises submitting the separation bag to a hydraulic pressure.

41. A method according to claim 30, wherein the composite liquid comprises whole blood, the first component comprises plasma, the second component comprises platelets, the third component comprise red blood cells and the intermediate component comprises a suspension of platelets in plasma.

42. A method according to claim 30, further comprising the step of transferring the third component from the separation bag into a third component bag connected to the separation bag at at least one third transfer flow rate, whereby the at least one third transfer flow rate is different from the at least one second transfer flow rate.

43. A method according to claim 42, wherein the at least one third transfer flow rate comprises an initial flow rate and a final flow rate, the final flow rate being lower than the initial flow rate.

44. A method according to claim 42, further comprising spinning the separation bag during the transfer of the third component from the separation bag into the third component bag at a centrifugation speed that is less than a centrifugation speed during the transfer of the intermediate component into the intermediate component bag.

45. A method according to claim 42, wherein the step of transferring the first component from the separation bag into the first component bag comprises:

allowing a flow of the first component through a first tube connecting the separation bag to the first component bag;

blocking a flow of the intermediate component through a second tube connecting the separation bag to the intermediate component bag;

blocking a flow of the third component through a third tube connecting the separation bag to the third component bag; and

squeezing the separation bag until the third component is detected on a pathway of the first component to the first component bag.

46. A method according to claim 42, wherein the step of transferring the intermediate component from the separation bag into the intermediate component bag comprises:

blocking a flow of the first component through a first tube connecting the separation bag to the first component bag;

allowing a flow of the intermediate component through a second tube connecting the separation bag to the intermediate component bag;

blocking a flow of the third component through a third tube connecting the separation bag to the third component bag; and

squeezing the separation bag until the third component is detected on a pathway of the intermediate component to the intermediate component bag.

47. A method according to claim 42, wherein the step of transferring the third component from the separation bag into the third component bag comprises:

blocking a flow of the first component through a first tube connecting the separation bag to the first component bag;

blocking a flow of the intermediate component through a second tube connecting the separation bag to the intermediate component bag;

allowing a flow of the third component through a third tube connecting the separation bag to the third component bag; and

squeezing the separation bag until it is substantially empty.

48. A method according to claim 47, further comprising the steps of:

detecting when the separation bag is substantially empty, and

stopping spinning the separation bag after detecting that the separation bag is substantially empty.

49. A method according the claim 42, wherein the step of squeezing the separation bag comprises:

submitting the separation bag to a hydraulic pressure; and

measuring the hydraulic pressure,

wherein the step of transferring the third component from the separation bag into the third component bag comprises:

transferring the third component at a first flow rate until the measured hydraulic pressure reaches a determined pressure threshold; and

transferring the third component at a second flow rate after the measured hydraulic pressure has reached the determined pressure threshold, the second flow rate being lower than the first flow rate.

50. A method according to claim 42, further comprising the step of transferring air from the separation bag into the third component bag before transferring the first component from the separation bag into the first component bag, said step comprising:

blocking a flow of the first component through a first tube connecting the separation bag to the first component bag;

blocking a flow of the intermediate component through a second tube connecting the separation bag to the intermediate component bag;

allowing a flow of the third component through a third tube connecting the separation bag to the third component bag; and

squeezing the separation bag until a liquid is detected on a pathway of the first component to the third component bag.

51. A method for separating a volume of a composite liquid into at least a first component and a second component, whereby the volume of composite liquid is contained in a separation bag connected to at least a first component bag and a second component bag, the method comprising the steps of:

spinning the separation bag so as to centrifuge the volume of composite liquid and cause the sedimentation of the at least first and second components ;

when the at least first and second components have sedimented, transferring at at least one first transfer flow rate the first component into the first component bag;

when the first component has been transferred into the first component bag, transferring at at least one second transfer flow rate the second component into the second component bag, whereby the at least one first and at least one second transfer flow rates are different.

52. A method according to claims 51, wherein the composite fluid comprises whole blood, the first component comprises plasma, and the second component comprises platelets.

53. A method according to claims 51, wherein the composite fluid comprises whole blood, the first component comprises plasma, and the second component comprises red blood cells.